

## MOBILE TERMINAL DEVICE AND METHOD OF UPDATING PROGRAM

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### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

10           The present invention relates to a mobile terminal device and a method of updating a program stored therein.

#### 2. Description of the Related Art

15           Update data are transmitted from a base station through a radio section to a mobile terminal for updating a program stored in the mobile terminal to obtain the new version of the program, wherein the program may, for example, be a system software for transmitting and receiving radio signals. Japanese laid-open patent publications Nos. 11-239094 and 11-298959 disclose the conventional methods of updating the program stored  
20   in the mobile terminal to obtain the new version of the program.

          First one of the updating methods is that the entirety of the program is updated. Second one of the updating methods is that only a difference between the old version of the program stored in the mobile terminal and the new version of the program is selectively updated. In

either of the methods, the updated data transmitted from the base station through the radio section are down-loaded into the mobile terminal for updating the program stored in the mobile terminal.

The conventional methods of updating the programs stored in the  
5 mobile terminal have the following disadvantages. A communication  
between the base station and the mobile terminal may be interrupted due to  
any defect of the electric field on the radio section or a voltage drop of a  
battery power of the mobile terminal. If a disconnection between the base  
station and the mobile terminal appears in the radio section during the  
10 transmission of the update data from the base station to the mobile terminal,  
then the transmission of the update data of the program stored in the mobile  
terminal is incomplete.

In accordance with the conventional updating methods, if the  
download of the update data into the mobile terminal is incomplete due to  
15 any interruption of the transmission, then the communication system do  
over the transmission of the update data again. This conventional method is  
the time-consuming method if the interruption of the transmission appears.

Even if the download of the update data into the mobile terminal  
is complete, and if the downloaded data include any defective data, then the  
20 updated program performs an abnormal function. The actual execution of  
the updated program makes it possible to verify whether the updated  
program is defective or non-defective. The conventional methods are  
enable to verify whether the updated program is defective or non-defective  
without actual execution of the updated program. If the defectiveness of the

updated program could be verified after the actual execution of the updated program, then it is necessary to again download the updated program into the mobile terminal. This procedure is inconvenient for the user of the mobile terminal.

- 5           In the above circumstances, the development of a novel method of updating the program stored in the mobile terminal free from the above problems is desirable.

### SUMMARY OF THE INVENTION

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Accordingly, it is an object of the present invention to provide a novel method of updating the program stored in the mobile terminal free from the above problems.

- 15           It is a further object of the present invention to provide a novel method of updating the program stored in the mobile terminal, which may perfect the update process efficiently even if the connection in the radio section is interrupted.

- 20           It is a still further object of the present invention to provide a novel method of updating the program stored in the mobile terminal, which may perfect the update process efficiently even if the originally downloaded update-data include any defective data.

It is yet a further object of the present invention to provide a novel mobile terminal capable of updating the program stored in the mobile terminal free from the above problems.

It is yet a further object of the present invention to provide a novel mobile terminal capable of updating the program stored in the mobile terminal, which may perfect the update process efficiently even if the connection in the radio section is interrupted.

- 5           It is yet a further object of the present invention to provide a novel mobile terminal capable of updating the program stored in the mobile terminal, which may perfect the update process efficiently even if the originally downloaded update-data include any defective data.

- 10           The present invention provides a method of updating a program in a terminal device is provided, wherein if a transmission of update data from a base station to a terminal device is interrupted due to any disconnection between them, then after it is verified that the terminal device becomes connected to the base station, the transmission process is re-started for remaining parts of the update data.

- 15           The above and other objects, features and advantages of the present invention will be apparent from the following descriptions.

## BRIEF DESCRIPTION OF THE DRAWINGS

- 20           Preferred embodiments according to the present invention will be described in detail with reference to the accompanying drawings.

FIG. 1 is a schematic view illustrative of a radio communication system including a base station and a mobile terminal for performing a program-updating operation in a first embodiment in accordance with the

present invention.

FIG. 2 is a schematic view illustrative of a part of the sequential process in FIG. 3.

FIG. 3 is a flow chart showing sequential operations of the above  
5 communication system if the updating process is successful.

FIG. 4 is a flow chart showing sequential operations of the above communication system if the updating process is completed in case of the disconnection during the update data transmission.

FIG. 5 is a flow chart showing sequential operations of the above  
10 communication system if the updating process is completed in case that the update data includes any defective data.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

15 A first aspect of the present invention is a method of updating a program in a terminal device, wherein if a transmission of update data from a base station to a terminal device is interrupted due to any disconnection between them, then after it is verified that the terminal device becomes connected to the base station, the transmission process is re-started for  
20 remaining parts of the update data.

It is preferable that the update data are divided into a plurality of data sets by the base station and the plural data sets are added with sequential pointers respectively.

It is preferable that after one with a next pointer for the

remaining data set is confirmed, then the data set with the next pointer is first transmitted during the re-transmission processes.

It is preferable that after all of the update data are transmitted, then an operation test is automatically started.

- 5           It is preferable that if updated program includes any defectiveness, the updated program is re-written into the program existent in the mobile terminal.

- 10           A second aspect of the present invention is a terminal device including : a receiving unit for receiving update data transmitted ; an updating unit for receiving the update data and updating an existent program with the update data ; and a re-starting unit for re-starting transmission process of remaining non-transmitted parts of the update data, after it is verified that the terminal device becomes connected to the base station, if a transmission of update data from a base station to a terminal  
15   device is interrupted due to any disconnection between them.

It is preferable to further comprise : an additional unit for transmitting the remaining data sets with reference to pointers added to the data sets.

- 20           It is preferable that after all of the update data are transmitted, then an operation test is automatically started.

It is preferable to further include a re-writing unit for re-writing the updated program into the program existent in the mobile terminal.

This second aspect of the present invention has the same characteristics described above in connection with the first aspect of the

present invention.

**FIRST EMBODIMENT:**

A first embodiment according to the present invention will be  
5 described in detail with reference to the drawings. FIG. 1 is a schematic  
view illustrative of a radio communication system including a base station  
and a mobile terminal for performing a program-updating operation in a  
first embodiment in accordance with the present invention.

The radio communication system may include a mobile terminal  
10 1, a base station 2 and a radio section 3 between the mobile terminal 1 and  
the base station 2. The mobile terminal 1 may include a transmitter unit 1-1,  
a receiver unit 1-2, a processor unit 1-3, a display unit 1-4, an operational  
unit 1-5, and a battery 1-6. The processor unit 1-3 may further include a  
first storage area 1A for storing a system software for the normal operation,  
15 a second storage area 1B for providing a save area to the system software, a  
third storage area 1C for storing a version-up process software, and an  
arithmetic unit 1D. The second storage area 1B is electrically coupled to  
the first storage area 1A. The arithmetic unit 1D is electrically coupled to  
the first storage area 1A and to the third storage area 1C.

20 In accordance with the radio communication system, the normal  
operation system software may be updated into a new version as follows.  
FIG. 3 is a flow chart showing sequential operations of the above  
communication system if the updating process is successful. FIG. 2 is a  
schematic view illustrative of a part of the sequential process in FIG. 3.

The arithmetic unit 1D is operable deepening on the normal operation system software stored in the first storage area 1A (#301).

In this state, the update request is sent from the base station 2 sends through the radio section 3 to the mobile terminal 1 (#302).

5           The arithmetic unit 1D instructs the display unit 1-4 to display where it is now updating the system software (#303).

The arithmetic unit 1D further inhibits any inputs from the operation unit 1-5 (#304).

10           The arithmetic unit 1D switches the normal operation system software into the updating operation system software (#305) and restarting, where the normal operation system software is stored in the first storage area 1A, whilst the updating operation system software is stored in the third storage area 1C. The normal operation system software is the system software to be implemented only in the normal operation. The updating  
15           operation system software is the system software to be implemented only in the normal operation.

20           After restart, the arithmetic unit 1D copies the normal operation system software from the first storage area 1A to the second storage area 1B (#306), whereby the normal operation system software is once moved to the second storage area 1B.

The arithmetic unit 1D sends an updating data send request from the transmitter unit 1-1 through the radio section 3 to the base station 2 (#307). The base station 2 receives the updating data send request. After the preparation of the download of the new version normal operation



system software is verified by the base station 2, the base station 2 sends updating data for the new version normal operation system software to the mobile terminal 1 (#308).

In this embodiment, the base station 2 divides the new version  
5 normal operation system software into first, second and third updating data sets (1), (2) and (3). The first, second and third updating data sets (1), (2) and (3) are respectively added with pointers which indicate sequences (#308-1), (#308-2) and (#308-3).

The mobile terminal 1 receives the first, second and third  
10 updating data sets (1), (2) and (3) from the base station 2 sequentially. The first storage area 1A stores the first, second and third updating data sets (1), (2) and (3) into the first storage area 1A, whereby the old version normal operation system software is rewritten into the new version normal operation system software.

After the new version normal operation system software has been  
15 stored into the first storage area 1A, the arithmetic unit 1D sends the base station 2 a notice that the update data completely received (#310), whereby the process for receiving the update data receiving process is completed. The base station 2 is notified from the mobile terminal by another notice  
20 that the new version normal operation system software has completely been downloaded.

After the notice of the receipt of the update data to the base station 2, the arithmetic unit 1D switches in use from the update operation system software stored in the third storage area 1C into the downloaded

new version system software stored in the first storage area 1A (#311) and re-start. After the re-start, the arithmetic unit 1D conducts the basic operation test in cooperation with the base station 2 such as the basic operations, for examples, transmission and receiving-operations for  
5 confirmation of the operation based on the updated system software(#312).

If the operation test verifies that the operation is completely correct (OK), then the arithmetic unit 1D sends the base station 2 a notice that the software was completely updated (#313).

The arithmetic unit 1D deletes the display of the updating  
10 operation on the display unit 1-4 (#314).

The arithmetic unit 1D releases the operation unit 1-5 from the input-inhibition state (#315).

The updated normal operation system software is used (#316).

If the connection between the mobile terminal 1 and the base  
15 station 2 is disconnected in the radio section 3 due to any reason such as the field defect or the power voltage drop of the mobile terminal 1, then the mobile terminal 1 operates as follows.

FIG. 4 is a flow chart showing sequential operations of the above communication system if the updating process is completed in case of the  
20 disconnection during the update data transmission.

The arithmetic unit 1D is operable deepening on the normal operation system software stored in the first storage area 1A (#401).

In this state, the update request is sent from the base station 2 sends through the radio section 3 to the mobile terminal 1 (#402).

The arithmetic unit 1D instructs the display unit 1-4 to display where it is now updating the system software (#403).

The arithmetic unit 1D further inhibits any inputs from the operation unit 1-5 (#404).

5       The arithmetic unit 1D switches the normal operation system software into the updating operation system software (#405) and restarting, where the normal operation system software is stored in the first storage area 1A, whilst the updating operation system software is stored in the third storage area 1C. The normal operation system software is the system  
10 software to be implemented only in the normal operation. The updating operation system software is the system software to be implemented only in the normal operation.

After restart, the arithmetic unit 1D copies the normal operation system software from the first storage area 1A to the second storage area  
15 1B (#406), whereby the normal operation system software is once moved to the second storage area 1B.

The arithmetic unit 1D sends an updating data send request from the transmitter unit 1-1 through the radio section 3 to the base station 2 (#407). The base station 2 receives the updating data send request. After  
20 the preparation of the download of the new version normal operation system software is verified by the base station 2, the base station 2 sends updating data for the new version normal operation system software to the mobile terminal 1 (#408).

In this embodiment, the base station 2 divides the new version

normal operation system software into first, second and third updating data sets (1), (2) and (3). The first, second and third updating data sets (1), (2) and (3) are respectively added with pointers which indicate sequences (#408-1), (#408-2) and (#408-3).

5           The mobile terminal 1 receives only the first updating data set (1) from the base station 2. The first storage area 1A stores the first updating data set (1) into the first storage area 1A (#409). The disconnection between the mobile terminal 1 and the base station 2 appears in the radio section 3, whereby the receiving process by the mobile terminal 1 is  
10 interrupted (#410).

The mobile terminal 1 does not receive the second and third updating data sets (2) and (3).

When the radio section becomes connectable state or the battery becomes power up (#411), the arithmetic unit 1D verifies the pointer of the  
15 completely received final update data set and decides the next pointer in connection with the next data set which should be received next.

This next pointer of the second update data set (2) is set in the updating data transmission request (#412) and sends the request to the base station 2 (#413).

20           The base station 2 receives the request with the next pointer from the mobile terminal 1. The data transmission is re-started from the second update data set (2) with the next pointer (#408-2').

The mobile terminal 1 receives the second and third update data sets (2) and (3) (#408-2', #408-3'), and then stores the second and third

update data sets (2) and (3) in the first storage area 1A (#414).

The first, second and third storage areas (1), (2) and (3) are completely stored in the first storage area 1A (#414). The old version system software is re-written into the new version system software.

5           After the new version normal operation system software has been stored into the first storage area 1A, the arithmetic unit 1D sends the base station 2 a notice that the update data completely received (#415), whereby the process for receiving the update data receiving process is completed. The base station 2 is notified from the mobile terminal by another notice  
10          that the new version normal operation system software has completely been downloaded.

          After the notice of the receipt of the update data to the base station 2, the arithmetic unit 1D switches in use from the update operation system software stored in the third storage area 1C into the downloaded  
15          new version system software stored in the first storage area 1A (#416) and re-start. After the re-start, the arithmetic unit 1D conducts the basic operation test in cooperation with the base station 2 such as the basic operations, for examples, transmission and receiving-operations for confirmation of the operation based on the updated system software(#417).

20           If the operation test verifies that the operation is completely correct (OK), then the arithmetic unit 1D sends the base station 2 a notice that the software was completely updated (#418).

The arithmetic unit 1D deletes the display of the updating operation on the display unit 1-4 (#419).

The arithmetic unit 1D releases the operation unit 1-5 from the input-inhibition state (#420).

The updated normal operation system software is used (#421).

If the update data includes any defective data, then the mobile  
5 terminal 1 operates as follows.

FIG. 5 is a flow chart showing sequential operations of the above communication system if the updating process is completed in case that the update data includes any defective data.

The arithmetic unit 1D is operable deepening on the normal  
10 operation system software stored in the first storage area 1A (#501).

In this state, the update request is sent from the base station 2 sends through the radio section 3 to the mobile terminal 1 (#502).

The arithmetic unit 1D instructs the display unit 1-4 to display where it is now updating the system software (#503).

15 The arithmetic unit 1D further inhibits any inputs from the operation unit 1-5 (#504).

The arithmetic unit 1D switches the normal operation system software into the updating operation system software (#505) and restarting, where the normal operation system software is stored in the first storage  
20 area 1A, whilst the updating operation system software is stored in the second storage area 1B. The normal operation system software is the system software to be implemented only in the normal operation. The updating operation system software is the system software to be implemented only in the normal operation.

After restart, the arithmetic unit 1D copies the normal operation system software from the first storage area 1A to the second storage area 1B (#506), whereby the normal operation system software is once moved to the second storage area 1B.

- 5           The arithmetic unit 1D sends an updating data send request from the transmitter unit 1-1 through the radio section 3 to the base station 2 (#507). The base station 2 receives the updating data send request. After the preparation of the download of the new version normal operation system software is verified by the base station 2, the base station 2 sends  
10   updating data for the new version normal operation system software to the mobile terminal 1 (#508).

- In this embodiment, the base station 2 divides the new version normal operation system software into first, second and third updating data sets (1), (2) and (3). The first, second and third updating data sets (1), (2)  
15   and (3) are respectively added with pointers which indicate sequences (#508-1), (#508-2) and (#508-3).

- The mobile terminal 1 receives the first updating data set (1) from the base station 2. The first storage area 1A stores the first updating data set (1) into the first storage area 1A (#509). Subsequently, the mobile  
20   terminal 1 receives the second updating data set (2) including defective data from the base station 2. Further, the mobile terminal 1 receives the third updating data set (3) including defective data from the base station 2, and then stores the second and third update data sets (2) and (3) in the first storage area 1A. The first, second and third storage areas (1), (2) and (3)

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are completely stored in the first storage area 1A. The old version system software is re-written into the new version system software.

After the new version normal operation system software has been stored into the first storage area 1A, the arithmetic unit 1D sends the base station 2 a notice that the update data completely received (#510), whereby the process for receiving the update data receiving process is completed. The base station 2 is notified from the mobile terminal by another notice that the new version normal operation system software has completely been downloaded.

10 After the notice of the receipt of the update data to the base station 2, the arithmetic unit 1D switches in use from the update operation system software stored in the third storage area 1C into the downloaded new version system software stored in the first storage area 1A (#511) and re-start. After the re-start, the arithmetic unit 1D conducts the basic  
15 operation test in cooperation with the base station 2 such as the basic operations, for examples, transmission and receiving-operations for confirmation of the operation based on the updated system software(#512).

If the operation test verifies that the operation is completely correct (OK), then the arithmetic unit 1D sends the base station 2 a notice  
20 that the result of the test is NG (#513).

The arithmetic unit 1D switches the normal operation system software into the updating operation system software (#514) and restarting, where the normal operation system software is stored in the first storage area 1A, whilst the updating operation system software is stored in the



second storage area 1B. The normal operation system software is the system software to be implemented only in the normal operation. The updating operation system software is the system software to be implemented only in the normal operation.

- 5           After restart, the arithmetic unit 1D copies the normal operation system software from the second storage area 1B to the first storage area 1A (#516), whereby the normal operation system software is the old-version software.

10           The arithmetic unit 1D deletes the display of the updating operation on the display unit 1-4 (#517).

          The arithmetic unit 1D releases the operation unit 1-5 from the input-inhibition state (#518).

          The non-updated normal operation system software is used (#519).

- 15           If the mobile terminal 1 becomes defective, it becomes necessary to solve the defective by improvement by the software in the mobile terminal 1. For avoiding the miss-matching with the non-use state of the mobile terminal, the base station retrieves the mobile terminal which have been in the non-use state for a predetermined time period or longer.

- 20           The base station 2 downloads the update data to the retrieved mobile terminal in accordance with the above-described sequential processes shown in FIG. 3. The base station 2 receives the notice of the completion of the processes from the mobile terminal. The base station 2 retrieves another mobile terminal which has been in the non-use state for a

predetermined time period or longer. The above other sequential processes shown in FIGS. 4 and 5 are made if any.

As described above, if the disconnection between the mobile terminal and the base station appears during the downloading process, then  
5 after the connection between the mobile terminal and the base station is again established, then the non-received next data sets are downloaded to the mobile terminal without re-downloading the once received data set.

Subsequent to the complete download of the entirety of the update data, then the operation test is made for confirmation of the  
10 operation based on the updated software.

If the updated software is defective, then the defective updated software is rewritten into the old-version software, whereby the mobile telephone becomes operable even in the old-version software.

In the foregoing descriptions, the entirety of the system software  
15 is re-written into the new version one. It is, off course, possible that the different part of the system software between the new and old versions is selectively subjected to the up-dating process efficiently.

The present invention is also applicable to the other software than the system software.

20 The present invention is also applicable to the other communication system between the non-mobile wireless terminal device and the base station.

The present invention is also applicable to the other communication system between the non-mobile wireless terminal device

and the base station.

The present invention is also applicable to the other communication system between the non-mobile wireless terminal device and the base station.

- 5           Although the invention has been described above in connection with several preferred embodiments therefor, it will be appreciated that those embodiments have been provided solely for illustrating the invention, and not in a limiting sense. Numerous modifications and substitutions of equivalent materials and techniques will be readily apparent to those skilled
- 10   in the art after reading the present application, and all such modifications and substitutions are expressly understood to fall within the true scope and spirit of the appended claims.